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(54) STEEL SHEET FOR CAN EXCELLENT IN AGING RESISTANCE AND
BAKING HARDENABILITY AND ITS PRODUCTION

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a steel sheet for a can high in baking
hardenability and free from the generation of aging deterioration at high temps.

SOLUTION: A slab contg., by weight, $\leq 0.08\%$ C, $\leq 0.10\%$ Si, $\leq 1.5\%$ Mn, $\leq 0.20\%$ P,
 $\leq 0.020\%$ S, 0.030 to 0.150% Al and $\leq 0.0030\%$ N is subjected to hot rolling at 800 to 950
C finish rolling temp., is coiled at $\geq 600^\circ\text{C}$, is subjected to cold rolling at $\geq 80\%$ draft and
is thereafter subjected to decarburizing treatment to attain ≥ 5 ppm decarburizing amt. by
continuous annealing of holding to the soaking temp. of the recrystallization temp. or
above for 10 to < 40 sec in an atmosphere having a gas compsn. composed of $\geq 3\%$
hydrogen, and the balance substantial nitrogen and at $\geq -20^\circ\text{C}$ dew point and is next
subjected to secondary cold rolling at 1 to 15% draft, by which a steel sheet having aging
resistance in which yield elongation in the case aging treatment is executed at 250°C for
60 sec is regulated to $\leq 3.0\%$ and baking hardenability in which the amt. to be baked in
the case heating treatment is executed at 210°C for 20 min after the application of 2%
prestrain is regulated to ≥ 40 MPa is obtd.

[Claim(s)]

[Claim 1] A steel-for-can board which is characterized by the following and which printed
with prescription-proof nature and was excellent in hardenability.

C: Less than 0.08wt%, less than Si:0.10wt%, less than Mn:1.5 wt%, less than P:0.20wt%,

less than S:0.020 wt%, aluminum:0.030 - 0.150 wt%, and less than N:0.0030wt%.
The amount of printing hardening of the remainder when percentage yield elongation when it consisted of Fe and inevitable impurities and aging treatment for 60 seconds was carried out by 250 ** carries out heat-treatment for 20 minutes by 210 ** below 3.0 % and after 2% prestrain ***** is more than 40 MPa.

[Claim 2]In claim 1, steel composition further Nb:0.003 - 0.040 wt%, And $\{Nb(wt\%)/93\} / \{C(wt\%)/12\} \leq 0.8$, Ti:0.003 - 0.040 wt% and $\{Ti^*(wt\%)/48\} / \{C(wt\%)/12\} \leq 0.8$, However, $Ti^*(wt\%) = Ti(wt\%) - (48/32) \times S(wt\%) - (48/14) \times N(wt\%)$, And a steel-for-can board containing any one sort chosen from B:0.0002 - 0.0020wt%, or two sorts or more which printed with prescription-proof nature and was excellent in hardenability.

[Claim 3]In claim 1 or claim 2, steel composition further Cu:0.01 - 0.2 wt%, nickel: A steel-for-can board containing any one sort chosen from Cr:0.01 - 0.2 wt% and Mo;0.01 - 0.2 wt%, or two sorts or more 0.01 - 0.2 wt% and which printed with prescription-proof nature and was excellent in hardenability.

[Claim 4]A steel-for-can board given in any 1 paragraph of claims 1-3, wherein the amount of dissolution C in steel is 5-15 ppm.

[Claim 5]A steel-for-can board given in any 1 paragraph of claims 1-4 characterized by giving at least one surface coating of a plating layer or an organic coating layer on the surface of a steel plate.

[Claim 6]C: Less than 0.08wt%, less than Si:0.10wt%, and less than Mn:1.5 wt%. P: Less than 0.20wt%, less than S:0.020 wt%, aluminum:0.030 - 0.150 wt%, N: About slab containing less than 0.0030wt%, it is finishing rolling temperature. It hot-rolls by 800 - 950 **, 600 After rolling round above ** and cold-rolling with not less than 80% of rolling reduction, not less than 3% of hydrogen and the remainder are the gas composition which consists of nitrogen substantially, In atmosphere which is more than - 20 **, by continuous annealing held for 10 seconds - less than 40 seconds, the dew point performs decarbonization processing used as the amount of decarbonization of not less than 5 ppm to soaking temperature more than recrystallizing temperature, and ranks second to it, A manufacturing method of a steel-for-can board which printed with prescription-proof nature and was excellent in hardenability performing secondary cold rolling of 1 to 15% of rolling reduction.

[Claim 7]A manufacturing method of the steel-for-can board according to claim 6 which performs overaging treatment which is cooled with a cooling rate at not less than 50 **/sec, and is held by 350 - 450 ** in continuous annealing after holding with soaking temperature.

[Claim 8]A manufacturing method of the steel-for-can board according to claim 6 or 7 depositing not less than 80% of the amounts of N in steel of hot rolled sheet steel as AlN

in hot-rolling, rolling up, and a subsequent cooling process.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the steel-for-can board used as various kinds of raw materials for containers.

It is related with a steel-for-can board to which it has prescription-proof nature and a molding defect is prevented, baking hardenability is revealed and the intensity of a can is raised by heating in the baking process of paint or printing, etc. after shaping, and a manufacturing method for the same until can shaping is performed especially.

[0002]

[Description of the Prior Art] The board thickness of what is called a steel-for-can board used for various containers including a beverage can and a food can is an ultra-thin steel plate of 0.3 or less mm.

As for those many, according to a use, tinning, nickel tinning, chrome plating (TIN free plating), etc. may be performed to the surface, and organic coating may be further performed on this.

At and the process of laminating a film in a steel plate as a steel plate which carried out organic coating with the film laminated steel for 2 piece cans which attracts attention especially these days It is heated by 210 - 250 **. After that, these surface coating steel plates are extracted, canning is carried out in response to fabricating operations, such as the 1st redrawing, the 2nd redrawing, and bottom product shaping, for example, and aging treatment is carried out by the case for an intensity rise of a can.

[0003] Now, the thinning of steel plate board thickness has recently been advanced from a viewpoint of a weight saving to a steel-for-can board. And the fall of the can intensity by board thickness reduction is compensated, and in order to aim at the reservation of can intensity which can be equal to practical use, what has high material strength has come to be called for inevitably. It has prescription-proof nature, a molding defect is prevented, and the steel plate in which the intensity of a can is raised by baking hardening by heating is ideal after shaping until a baking hardenability steel plate, i.e., can shaping, is performed, in order to control the fall of the molding workability by intensity rise moreover to meet this request. If it is insufficient here as prescription-proof nature that it is just the conventional ordinary temperature ***** and it is in the raw material for 2 piece cans using the above-mentioned film laminate especially, it is a laminating process before a fabricating operation. Even when heat-treatment by 210 - 250 ** is received, it is necessary not to carry out prescription.

[0004] By the way, in the steel plate for cars, some proposals are made about the baking hardenability steel plate until now. For example, Japanese Patent Publication No. 5 - 48283 The method of an item gazette is mainly specifying a steel composition, and tends to control the amount of dissolution C in steel in the proper range. this and the similar art of JP,57-192225, A control dissolution / deposit action of Nb, and adjust the amount of C

of a dissolution state. It is a thing of the thought of preventing that re-deposit and making the dissolution C of an appropriate range remain by annealing at not less than 850 ** and an elevated temperature, making a part of NbC of a separation state re-dissolve in this invention, and quenching from that state.

[0005]

[Problem(s) to be Solved by the Invention]however -- since the target use mainly calls such conventional technologies mentioned above the steel plate for cars -- board thickness -- in general -- It is aimed at a thing of 0.7 mm or more. For this reason, pyrosphere annealing whose carbon nitride is made to dissolve and which is performed for accumulating is inapplicable to the manufacture of a steel-for-can board very as thin as 0.3 mm or less which this invention makes an object as it is. When an ultra-thin steel plate is annealed by such a pyrosphere, because of the rigid fall by board thickness being thin, it is a continuous annealing process and is because the trouble of the defect of shape by buckling of a steel plate is caused. The point that a steel-for-can board is greatly different from the steel plate for cars, To press forming being fundamentally presented with the steel plate shipped from the iron and steel maker in the state as it is, in a steel-for-can board, in many cases, in the steel plate for cars, after paint, printing, etc. are performed, press forming of the steel plate shipped from the iron and steel maker is carried out. That is, by paint and heating by 210 - 250 ** accompanying presswork, it is fabricated, after receiving aging treatment very severer than the steel plate for cars. If prescription-proof nature (the prescription produced by the stage of can shaping by press forming etc. is said in this invention) is not enough, the appearance defect by generating of fluting and a stretcher strain, etc. will be caused at the time of can shaping. A demand to the prescription-proof nature in this elevated temperature is severe several steps compared with the general prescription-proof nature known from the former, i.e., ordinary temperature *****.

[0006]Two piece cans which perform draw forming with big prescription-proof nature in such an elevated temperature (integral moulding of a bottom and the trunk is carried out, and) From the first, even if simple cylinder shaping twisted for bending is a subject's three piece can (can of a gestalt in which the bottom, the trunk, and the canopy were together put as respectively separate parts), the can of a gestalt in which the canopy was combined with it, After cylinder shaping, when fabricating the secondary drum section to the anomaly according to a barrel type or this, it is especially needed.

[0007]In the conventional steel-for-can board, the method taken in order to avoid appearance defects mentioned above, such as fluting at the time of fabricating after paint and baking and a stretcher strain, was lowering prescription nature chiefly. However, in this solution, on the other hand, can intensity (internal pressure resistance, axial compression-proof intensity, etc.) is made to fall, and it disagrees with the movement toward the rationalization which is going to advance the thinning of a steel plate.

[0008]As stated above, in the characteristic use of the object for cans, it is very difficult to reconcile baking hardenability and hot prescription-proof nature industrially in conventional technology, and there was no method of only the correspondence at the

sacrifice of either of these both the characteristics. For this reason, it was not able to respond to the latest request of manufacturing a healthy can without a defect, attaining a weight saving.

[0009]Then, in view of the problem which the above-mentioned conventional technology was holding, in a stage until it results in can shaping, the main purpose of this invention has artificial-aging-proof nature, and after it carries out can shaping, there is in providing the steel-for-can board with which the big baking hardenability by high temperature processing is brought about, and its manufacturing method. Percentage yield elongation when aging treatment is carried out for 60 seconds by 250 ** is below 3.0 %, and the concrete purpose of this invention has the amount of printing hardening when it heat-treats for 20 minutes by 210 ** in providing the steel-for-can board which becomes more than 40 MPa, and its manufacturing method after 2% prestrain *****.

[0010]

[Means for Solving the Problem]In order that artificers might solve the above-mentioned problem, they worked on a policy for printing with hot prescription-proof nature and reconciling hardenability from a new standpoint, and repeated an experiment and research. As a result, adopting manufacturing conditions which leave the dissolution C as the whole steel plate, by strong-decarbonizing a steel sheet surface for a short time at the time of annealing, by making distribution of C unevenly distributed in a board thickness direction, knowledge that it is solvable at once is acquired, and it came to complete this invention. The gist composition is as follows.

[0011]

1) Less than C:0.08wt%, less than Si:0.10wt%, and less than Mn:1.5 wt%. P: Less than 0.20wt%, less than S:0.020 wt%, aluminum:0.030 - 0.150 wt%, Contain less than N:0.0030wt% and the remainder consists of Fe and inevitable impurities, 250 A steel-for-can board which printed with prescription-proof nature and was excellent in hardenability, wherein the amount of printing hardening when percentage yield elongation when aging treatment for 60 seconds was carried out by ** carries out heat-treatment for 20 minutes by 210 ** below 3.0 % and after 2% prestrain ***** is more than 40 MPa.

[0012]In the above 1, steel composition further 2) Nb:0.003 - 0.040 wt%, And $\{Nb(wt\%)/93\} / \{C(wt\%)/12\} \leq 0.8$, Ti:0.003 - 0.040 wt% and $\{Ti^*(wt\%)/48\} / \{C(wt\%)/12\} \leq 0.8$, However, $Ti^*(wt\%) = Ti(wt\%) - (48/32) \times S(wt\%) - (48/14) \times N(wt\%)$, And a steel-for-can board containing any one sort chosen from B:0.0002 - 0.0020wt%, or two sorts or more which printed with prescription-proof nature and was excellent in hardenability.

[0013]In the above 1 or 2, steel composition further 3) Cu:0.01 - 0.2 wt%, nickel: A steel-for-can board containing any one sort chosen from Cr:0.01 - 0.2 wt% and Mo;0.01 - 0.2 wt%, or two sorts or more 0.01 - 0.2 wt% and which printed with prescription-proof nature and was excellent in hardenability.

[0014]4) A steel-for-can board of any one statement of the above 1-3, wherein the amount of dissolution C in steel is 5-15 ppm.

[0015]5) A steel-for-can board of any one statement of the above 1-4 characterized by giving at least one surface coating of a plating layer or an organic coating layer on the surface of a steel plate.

[0016]

6) Less than C:0.08wt%, less than Si:0.10wt%, and less than Mn:1.5 wt%. P: Less than 0.20wt%, less than S:0.020 wt%, aluminum:0.030 - 0.150 wt%, N: About slab containing less than 0.0030wt%, it is finishing rolling temperature. It hot-rolls by 800 - 950 **, 600 After rolling round above ** and cold-rolling with not less than 80% of rolling reduction, not less than 3% of hydrogen and the remainder are the gas composition which consists of nitrogen substantially, In atmosphere which is more than -20 **, by continuous annealing held for 10 seconds - less than 40 seconds, the dew point performs decarbonization processing used as the amount of decarbonization of not less than 5 ppm to soaking temperature more than recrystallizing temperature, and ranks second to it, A manufacturing method of a steel-for-can board which printed with prescription-proof nature and was excellent in hardenability performing secondary cold rolling of 1 to 15% of rolling reduction.

[0017]7) A manufacturing method of a steel-for-can board given in the above 6 which performs overaging treatment which is cooled with a cooling rate at not less than 50 **/sec, and is held by 350 - 450 ** in continuous annealing after holding with soaking temperature.

[0018]8) Hot-rolling, rolling up, and subsequent cooling process (radiational cooling is also included) Manufacturing method of a steel-for-can board given in the above 6 or 7 which sets and is characterized by depositing not less than 80% of the amounts of N in steel of hot rolled sheet steel as AlN.

[0019]

[Embodiment of the Invention]Next, the reason which limited component composition, manufacturing conditions, etc. as the above-mentioned gist composition is explained.

(1) It is a harmful element which less than C:0.08wt%C reduces [element] ductility about a steel composition, and worsens processability. since the influence will become remarkable if less than 0.08wt% is exceeded especially -- less than 0.08wt% -- less than 0.004wt% is used preferably. however -- in order to acquire effective baking hardenability -- more than 0.002 wt% -- it shall be desirable to make it contain and it shall increase according to the required amount of baking hardening As for the amount of dissolution C in steel, it is desirable that it is the range of 5-15 ppm. Internal friction can analyze the amount of dissolution C here, and both are checking having a good correspondence relation. Unless this value is less than 5 ppm, sufficient baking hardening characteristic is not obtained, but on the other hand, if it exceeds 15 ppm, prescription-proof will deteriorate. Internal friction and the amount of dissolution C have the

following relation.

[Dissolution Cwt%] = 1.16 and Q^{-1}_{\max} (being here Q^{-1}_{\max} : peak value of an internal friction curve) [0020]Si: If it adds [less than 0.10wt%Si] so much, since degradation of surface treatment nature, corrosion-resistant degradation, etc. will be caused, it makes the maximum 0.10wt%. When the especially outstanding corrosion resistance is required, restricting to less than 0.02wt% is preferred.

[0021]Mn: When less than 1.5 wt%Mn prevents hot tearing resulting from S, it is an effective element, and it is good to add according to the amount of S to contain. Mn carries out minuteness making of the crystal grain, and is an element effective in improvement in construction material. in order to demonstrate these effects -- more than 0.1 wt% -- adding is desirable. On the other hand, since corrosion resistance will fall and flange processability will deteriorate although high intensity-ization of a steel plate can be attained if Mn is added so much, a maximum is made into 1.5 wt%. For the use as which a better moldability is required, it is desirable to use less than 0.80wt%.

[0022]P: When less than 0.20wt%P attained high intensity-ization by solid-solution-strengthening operation, it was a useful element, but when contained so much, while making steel make it hard and degrading flange processability and neck processability, in order to reduce corrosion resistance, it made the maximum 0.20wt%. When thinking processability and corrosion resistance as important, it is preferred to hold down to less than 0.01wt%.

[0023]S: Less than 0.020 wt%S is an element which exists as inclusion in steel, reduces ductility, and brings about further corrosion-resistant degradation. Since these influences will appear notably if S content exceeds 0.020 wt%, it restricts to less than 0.020 wt%. It is desirable to control especially for the use as which good processability is required at less than 0.005 wt%.

[0024]Although aluminum:0.030 -0.150 wt%aluminum is an element required since it is stabilized and N is fixed and addition beyond 0.030 wt% is required for it, Since it will lead to the phenomenon of generating of the flange crack by degradation of a surface disposition, increase of the anisotropy of a rolling direction, and elasticity-izing of a weld zone if contained so much, the maximum is made into 0.150 wt%. In order [of construction material / further] to be stable, it is desirable to add in 0.040 - 0.080wt% of the range.

[0025]N: Less than 0.0030wt%N is an element to which prescription nature is made to increase, and it is desirable to make it decrease as much as possible. In this invention, the baking hardening characteristic is not depended on N, but fixed stabilization is carried out by setting N to AlN by addition of aluminum which aims at obtaining only by C and described it above. However, it becomes difficult to be stabilized if the amount of N exceeds 0.0030wt%, and to fix N. therefore, the amount of N -- less than 0.0030wt% -- less than 0.0025wt% is used preferably.

[0026]The element stated to the next other than the above basic element can be added selectively.

Nb: 0.003 - 0.040 wt%, and $\{Nb(wt\%)/93\} / \{C(wt\%)/12\} \leq 0.8$ Nb are an element which has an effect in the minuteness making of a crystal grain, and the improvement in beauty of the fabricated steel sheet surface while reducing the dissolution C and N by forming carbon nitride. Although these effects are demonstrated by addition beyond 0.003 wt%, if it adds exceeding 0.040 wt%, steel will become hard and the danger of it not only causing trouble, but generating a crack at a slab casting process at a cold rolling process will increase. Therefore, the addition of Nb is made into 0.003 - 0.040 wt%. It is desirable to consider it as 0.005 - 0.02wt%, for it is stabilized and securing the amount of baking hardening. If the atomic ratio of Nb and C, i.e., $\{Nb(wt\%)/93\} / \{C(wt\%)/12\}$ exceeds 0.8, it will become difficult to acquire the baking hardenability of sufficient target quantity. For this reason, it is said atomic ratio 0.8 0.75 or less are used preferably hereafter.

[0027]Ti: 0.003 - 0.040 wt%, and $\{Ti^*(wt\%)/48\} / \{C(wt\%)/12\} \leq 0.8$ however $Ti^*(wt\%) = Ti(wt\%) - (48/32) \times S(wt\%) - (48/14) \times N(wt\%)$

Ti is also an element effective in reducing the amount of dissolution C like Nb, and the minuteness making of an organization. Although such an effect is demonstrated by addition beyond 0.003 wt%, it will print, if it adds exceeding 0.04wt%, and the amount of hardening falls. Therefore, the addition of Ti is made into 0.003 - 0.040 wt%. In order to be stabilized and to secure the amount of baking hardening, it is desirable to consider it as 0.005 - 0.020 wt% of the range. The atomic ratio of Ti and C, i.e., $\{Ti^*(wt\%)/48\} / \{C(wt\%)/12\} \leq 0.8$, However, if $Ti^*(wt\%) = Ti(wt\%) - (48/32) \times S(wt\%) - (48/14) \times N(wt\%)$ ** exceeds 0.8, it will become difficult to acquire the baking hardenability of sufficient target quantity. For this reason, it is said atomic ratio 0.8 0.75 or less are used preferably hereafter.

[0028]B: 0.0002-0.0020wt%B is an element effective in improving prescription-proof nature hot [required for a steel-for-can board], without reducing the baking hardenability of a steel plate, although a detailed mechanism is not necessarily clear. Although such an effect is demonstrated by addition beyond 0.0002wt%, since this effect is not only saturated, but the plane anisotropy of the mechanical property of a steel plate will increase if it adds exceeding 0.0020wt%, it is added in 0.0002 - 0.0020wt% of the range. It is preferred to add in 0.0005 - 0.0010wt% of the range from the point of stabilization of mechanical properties and equalization.

[0029]Cr:0.01 - 0.2 wt% and Mo:0.01-0.2 wt%Cu, nickel, Cr, and Mo nickel:0.01 - 0.2 wt% Cu:0.01 - 0.2 wt%, It has an almost similar construction material improvement effect, and contributes to coexistence of the prescription-proof nature before shaping, and press-forming nature under existence of an appropriate amount of the amounts of dissolution C. Although such an effect is demonstrated from addition beyond 0.01wt%, even if it adds exceeding 0.2 wt%, the danger that in addition to an effect being saturated a hot-rolling motherboard will become hard and will generate the fault in a cold rolling process increases. Since the above-mentioned effect is not offset even if it carries out compound addition of these elements, either of independent addition and compound

addition is obtained.

[0030]- Although they differ with the target mold goods etc., hot prescription-proof nature and baking hardenability hot prescription-proof nature are enough practically, if the prescription of maintenance is borne for 60 seconds in 210 **. If the value of such breakdown point elongation recovered by an aging condition is below 3.0 %, the appearance defect by generating of a stretcher strain etc. will not be caused at the time of press forming. Baking hardenability is required in order to guarantee the strength property at the time of use of forming parts. And in the can use which needs the moldability which was excellent like this invention with the board thickness of a steel plate, and a demand intensity level although the required amount of hardening changed, if there is the amount of baking hardening more than 40 MPa, it is enough practically. Here, when prescription for 20 minutes is performed in 210 ** after the value of the amount of baking hardening cut down the test piece for tensile test from the steel plate and gave 2% of *****, the increase of stock of the flow stress a prescription front and after prescription prescribes it. An upper yield point estimates the flow stress after prescription.

[0031](2) About manufacturing conditions, perfect solution-ization should just be made and heating of the steel stock before - hot-rolling hot-rolling should just be heated beyond Ac_3 point. Specifically, 1050-1300 ** is suitable. In hot-rolling following the above-mentioned heating, finishing rolling temperature secures the homogeneity of the construction material in the ductility, the longitudinal direction, and the cross direction of a steel plate, and also it is [from] important. And in order to obtain high target ductility and the homogeneity of construction material, it is finishing rolling temperature. It is required to consider it as not less than 800 **. However, if it rolls by finishing exceeding 950 **, the load of hot-rolling RORUHE will increase, and also generating of the crack resulting from the scale by which it is generated during rolling also becomes remarkable. therefore, finishing hot-rolling temperature 800-950 ** -- desirable -- It is considered as the temperature requirement of 840 - 920 **.

[0032]- Rolling-up temperature rolling-up temperature affects the immobilization where N by aluminum was stabilized. deposit immobilization of N according to aluminum by carrying out this rolling-up temperature more than 600 ** -- a hot-rolling coil -- it can attain covering an overall length mostly. Although it is not necessary to define the maximum in particular of rolling-up temperature, it is desirable to hold down to below 780 **, considering the viewpoint of controlling aggravation of descaling nature.

[0033]- Pickling and after cold-rolling is carried out, continuous annealing of the rate hot-rolling board of AlN occupied in the amount of N in a hot-rolling board is carried out. Although a part of dissolution N deposits as AlN in the case of this continuous annealing, since annealing time is short, it is difficult to deposit the dissolution N thoroughly. If N of a dissolution state exists after annealing, recovery of percentage yield elongation will become remarkable. For this reason, the thing of N of the amount of N in steel deposited not less than 85% preferably not less than 80% is desirable in the stage of a hot-rolling board. N of the separation state specified here analyzed AlN by electrolytic extraction

analysis usually carried out, and also it puts the amount (N as AlN and brief sketch) of N computed from equivalent relations. In order to carry out deposit immobilization of the inside N of steel in a mentioned range, control of the coiling temperature after hot-rolling mentioned above is very important.

[0034]- Cold rolling cold-rolled rolling reduction is considering it as not less than 80%, and since an organization becomes uniformly and detailed, the usual tractive characteristics are improved. Since the efficiency of the decarbonization at the time of annealing also improves and short-time annealing is attained, it is advantageous in the viewpoint of improvement in productivity. For this reason, rolling reduction in cold rolling is made into not less than 80%. Prescription-proof nature and baking hardenability can be preferably acquired by being stabilized efficiently not less than 82% by considering it as not less than 85% still more preferably.

[0035]- The decarbonization continuous annealing process by continuous annealing is one of the especially important requirements in this invention. not less than 3% of hydrogen and the remainder consist of nitrogen substantially, and gas composition performs continuous annealing held for less than 40 seconds 10 seconds or more to the temperature more than recrystallizing temperature in the atmosphere whose dew point is more than -20 °C -- the inside of an annealing process -- 0.0005wt% (5 ppm) -- the above decarbonization is produced. This amount of decarbonization is calculated from the difference of the amount of C by the board thickness direction penetration analysis before and after decarbonization. Thus, it becomes possible by making a short time of less than 40 seconds produce the decarbonization more than 5 ppm 10 seconds or more to reconcile the prescription-proof nature hot [outstanding] aimed at by this invention, and sufficient baking hardenability. At this invention, it is unnecessary and hot annealing [as / in the steel plate for cars, etc.] is annealing temperature. It is enough below 850 °C.

[0036]Although the detailed mechanism about the phenomenon in which the above-mentioned effect is acquired by decarbonization is not necessarily clear, it presumes as follows. Decarbonization uses a surface reaction, and it produces the concentration gradient of big C from a surface toward the inside of a steel plate in a short-time nonequilibrium state in order to remove C in steel from the layer part of a steel plate at a solid-gas reaction as CO (or there is possibility of CH₄ and CO₂). Although it is difficult to actually analyze the concentration distribution in the board thickness direction of this C, when it calculates by assuming a reaction to be a diffusion limitation of C, it comes to be shown in drawing 1. It is verifiable that this analysis result is appropriate to some extent from corresponding well with C analytical value after [before C content with which it integrated to the board thickness direction annealing] annealing.

[0037]And in the state (drawing 2 (a)) where C has a concentration gradient in this way in the board thickness direction, as for 1 to 10% of rolling reduction, when 1 to 15% of secondary cold rolling is given preferably, a movable rearrangement will be introduced into the field with very few amounts of C of a layer part. namely, adherence according [the movable rearrangement introduced into a layer part] to C -- easy -- **** -- **** (drawing 2 (b)) -- it becomes things. Thereby, the prescription-proof nature before

extremely outstanding press forming can be attained. In an ultra-thin steel plate for cans called below 0.3 mm in board thickness, paint printing or adhesion of an organic resin film is performed before press forming, and it is ****. Manufacture of 2 piece cans prosperous these days using film laminated steel is this classic example. In this case, although heated by the temperature about 210 - 250 **, since retention time is as short as 40 or less seconds, compared with the prescription by baking after press working of sheet metal described below, the grade of age deterioration is comparatively small. Therefore, if this invention steel plate is used, there is little age deterioration before press forming. When only the surface of a steel plate is made into *****, the reason which does not produce defects, such as fluting, easily due to press forming is because many movable rearrangements exist in the surface which is the starting point of plastic deformation.

[0038]On the other hand, in the stage which fabricates a steel plate, the plastic-working distortion of not less than about at least 5% will be given, and aging treatment for 20 minutes will be performed by about 210 ** after that. In this case, naturally modification is started over the thickness direction whole region of a steel plate, and many rearrangements are introduced newly. And especially in the case of the aging treatment by baking after this shaping, among steel, in a board thickness direction center section, since the dissolution C of sufficient quantity which adheres these the rearrangements of a lot of remains, the big target baking hardening characteristic is obtained (drawing 2 (c)).

[0039]In order to produce the above effective decarbonization reactions, continuous annealing in which rapid heating and forced cooling are possible is suitable as annealing technique. including an annealing atmosphere for not less than 3% of hydrogen as annealing conditions -- the remainder -- substantial -- nitrogen and the dew point -- more than -20 ** -- desirable -- 1 -- it is considered as not less than 10 **, and it is more than recrystallizing temperature and it is necessary to perform continuous annealing for less than 40 seconds which carries out short-time maintenance 10 seconds or more It becomes insufficient about less than 3% and the dew point decarbonizing the case where hydrogen is less than [-20 **] and annealing time is any for less than 10 seconds. In 40 seconds or more, the amount of decarbonization has too much annealing time, the concentration gradient of a board thickness direction becomes small, and since the fall of very big productivity will be brought about in that BH nature falls and a continuous annealing process, annealing is performed in a mentioned range. measuring the amount of C in steel annealing before and after annealing by board thickness direction penetration analysis as an amount of decarbonization -- the difference -- 0.0005wt% (5 ppm) -- if the decarbonization which it is above is produced, the outstanding artificial-aging-proof nature for which it asks, and sufficiently big baking ***** will be obtained. Although the maximum in particular of the amount of decarbonization is not defined, when maintaining the detergency inside a furnace, it is desirable to consider it as 0.05% or less.

[0040]- After being decarbonized by continuous annealing in continuous annealing which carried out overaging treatment ****, overaging treatment can be added if needed. After especially quenching in sec in not less than 50 ** /from the soaking temperature of said decarbonization with low carbon steel (about C:0.01-0.08wt%), it is effective to perform overaging treatment in the temperature requirement of 350 - 450 **, when improving hot

prescription-proof nature further. At this time, the efficiency of overaging can be raised more after soak by carrying out the cooling rate to overaging starting temperature in not less than 50 °C/[sec and]. Since overaging temperature reduces prescription nature as much as possible by short-time processing, it is desirable to consider it as the temperature requirement of 350 - 450 °C. If it is in this temperature requirement, it is not necessary to hold to a fixed temperature in particular. Retention time is 40-300. It is desirable to consider it as the range of a second.

[0041]- Although it usually carries out at the lightly pressurizing rate about 0.8 %, in this invention, the secondary secondary cold rolling cold rolling (temper rolling) needs to give rolling of higher rolling reduction so that sufficient artificial-aging-proof characteristic may be obtained. That is, it can control by giving 1% or more of pressing down below to 3.0 which are desired value of percentage yield elongation when aging treatment is carried out for 60 seconds by 250 °C %. However, if it rolls with the rolling reduction exceeding 15%, the ductility of a steel plate, and since especially uniform elongation falls, the danger of producing faults, such as a crack, at the time of press forming will increase. Therefore, let rolling reduction of secondary cold rolling be the rolling reduction of 1 to 15%. When the artificial-aging-proof characteristic of having excelled further is required, it is desirable to give a rolling strain for rolling reduction in 2 to 3% of range.

[0042]

[Example]An example explains this invention to the primary example. The steel in which the remainder consists of Fe(s) substantially with the component composition shown in Table 1 was ingoted with the converter, hot-rolling, continuous annealing, and secondary cold rolling were performed on the conditions which show this steel slab in Table 2, and the last board thickness was used as the cold rolled sheet steel of 0.3 mm. Thus, from the obtained steel plate, the JIS No. 5 specimen was extracted and a usual mechanical property, prescription-proof nature in artificial aging, and baking hardenability were investigated. About prescription-proof nature, aging treatment for 60 seconds was performed to the test piece for tensile test extracted similarly with the thermostat by 250 °C equivalent to the paint before canning, and baking finish. After baking hardenability gave 2% of prestrain, unloading of it was once carried out, it gave the aging treatment for 20 minutes in 210 °C, performed tension again, and searched for it from the difference of the flow stress in front of prescription, and the yield stress after prescription. These results of an investigation are shown in Table 3.

[0043]

[Table 1]

鋼	C	Si	Mn	P	S	Al	N	Nb, Ti, B	Cu, Ni, Cr, Mo	備 考
1	0.0028	0.01	0.10	0.010	0.015	0.055	0.0015	Nb/0.008		適合例
2	0.0022	0.02	0.30	0.005	0.005	0.050	0.0018			〃
3	0.0072	0.01	0.25	0.005	0.001	0.080	0.0021			〃
4	0.0451	0.02	0.15	0.015	0.007	0.028	0.0020	Ti/0.015		〃
5	0.0753	0.01	0.10	0.007	0.008	0.120	0.0022		Mo/0.02	〃
6	0.0025	0.01	0.45	0.005	0.015	0.081	0.0021	Nb/0.004 B/0.0005		〃
7	0.0024	0.01	0.25	0.005	0.009	0.060	0.0011		Cu, Ni, Cr ／各0.05	〃
8	0.0025	0.01	0.55	0.004	0.010	0.050	0.0012	Nb/0.003 Ti/0.005		〃
9	0.120	0.01	0.15	0.005	0.002	0.040	0.0045			比較例
10	0.0022	0.02	0.30	0.005	0.005	0.051	0.0015	Nb/0.003	Cu/0.05 Ni/0.05	適合例

[0044]

[Table 2]

スラブ 加熱 温度 (℃)	仕上げ 圧延 温度 (℃)	仕上 厚み (mm)	巻取 温度 (℃)	冷延圧下率 (%) (冷延厚mm)	連続焼鈍条件				二次冷延 圧下率 (%)
					焼鈍温度 (℃)	雰囲気	露 点 (℃)	焼鈍時間 (sec)	
1180	885	2.0	680	84.5 % (0.31)	750	4% H_2 —残 N_2	—10	20	2

[0045]

[Table 3]

	熱延板中の N as AlN の割合 (%)	焼鈍後の C量 (%)	脱C量 (ppm)	固溶 C量 (ppm)	鋼 板 の 特 性				
					平均 r 値	伸び (%)	T S (MPa)	250℃-60sec 時効後の降伏 伸び (‰)	焼付 硬化量 (MPa)
1	85	0.0021	7	7	1.9	49	328	2	45
2	85	0.0015	7	9	2.0	49	315	2	47
3	90	0.0054	18	8	1.9	46	330	1.5	51
4	85	0.0420	31	10	1.4	45	355	1	50
5	90	0.0681	72	7	1.4	45	350	1.5	52
6	90	0.0016	9	10	2.0	49	340	0.5	41
7	85	0.0016	8	6	1.9	48	380	1.5	55
8	85	0.0015	10	10	1.9	47	330	1.0	48
9	82	0.102	180	20	1.1	41	380	3.5	15
10	85	0.0016	8	10	1.8	48	330	2	45

[0046]While the steel plate according to this invention had the baking hardening characteristic more than 40 MPa from Tables 1-3, an elevated temperature and severe prescription also showed not producing breakdown point elongation. For this reason, the appearance defect by generating of a stretcher strain etc. is not produced by a fabricating operation, either. Also in actual press forming, the rise of the mold-goods intensity by printing hardening as expected and control of stretcher-strain generating were attained, and this was proved.

[0047]To the steel 1 of the example 2 table 1 according to each manufacturing conditions (however performing nickel plating before continuous annealing decarburization annealing and nickel homogenizing simultaneous operation) shown in Table 4. The cold rolled sheet steel which has a diffusion zone of nickel on the surface was manufactured, tinning was performed with the electric tinning line, reflow treatment was performed with in-line one and the steel plate which has the tin phase of island shape was manufactured. Then, after painting and burning resin on the surface, prescription-proof nature and baking hardenability were investigated like Example 1. The result is shown in Table 5. As a result, it turned out that breakdown point elongation is not produced in the above severe prescription, and the appearance defect by stretcher-strain generating etc. is not produced while the resin coating composite-coatings steel plate according to this invention method has the baking hardening characteristic of 40 or more MPa. When press forming was actually performed, the rise of the mold-goods intensity by printing hardening as expected and control of stretcher-strain generating were attained.

[0048]

[Table 4]

	仕上げ 圧延 温度 (℃)	巻取 温度 (℃)	熱延板中 N as AlN の割合 (%)	冷延 圧下率 (%)	連続焼鈍条件				脱炭量 (ppm)	二次 冷延 圧下率 (%)
					温 度 (℃)	雰囲気	露 点 (℃)	時 間 (sec)		
1	880	680	90	85	760	3 %H ₂ —残N ₂	—10	25	10	2
2	900	710	95	88	755	4 %H ₂ —残N ₂	—15	15	9	3
3	910	640	88	90	740	4 %H ₂ —残N ₂	— 7	20	8	3
4	850	<u>450</u>	<u>40</u>	85	750	5 %H ₂ —残N ₂	—10	20	8	2
5	850	710	90	<u>73</u>	750	3 %H ₂ —残N ₂	<u>—35</u>	25	<u>1</u>	2
6	900	680	90	85	750	5 %H ₂ —残N ₂	—15	40	8	5
7	850	650	85	85	750	5 %H ₂ —残N ₂	—15	<u>100</u>	20	2

[0049]

[Table 5]

	固溶C量 (ppm)	平均r値	伸 び (%)	T S (MPa)	250℃-60sec 時効後の降伏 伸び (%)	焼付 硬化量 (MPa)	摘 要
1	9	2.03	49	325	1.0	45	発明例
2	10	2.14	49	310	1.0	42	“
3	12	1.95	47	320	1.0	43	“
4	13	1.05	41	315	3.7	45	比較例
5	23	1.85	46	325	3.5	43	“
6	11	2.10	49	312	1.0	44	発明例
7	3	2.00	45	300	0.5	5	比較例

[0050]

[Effect of the Invention]As explained above, by this invention hot-rolling and after carrying out cold-rolling, according to the continuous annealing process in a short time. A steel sheet surface is decarbonized, the concentration distribution of C is formed positively in a board thickness direction, temper rolling higher further comparatively is given and it becomes possible [providing the steel-for-can board which combines the difficult big baking hardenability and the outstanding prescription-proof nature] to make it conventionally compatible. Therefore, since intensity rises greatly by baking hardening and the steel plate by this invention shows high can intensity when it is excellent in a moldability and is moreover actually used as a product by elasticity at the time of press forming or an assembly, the board thickness reduction of a steel plate required to obtain the same can intensity of it is attained.